CLAIMS

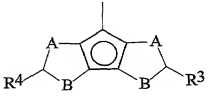
1. A metallocene compound of general formula (I):

LGZMXp (I)

wherein

L is a divalent group bridging the moieties G and Z, selected from CR^1R^2, SiR^1R^2 and $(CR^1R^2)_2$, R^1 and R^2, which may be the same as or different from each other, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing a heteroatom, which can form a ring having 3 to 8 atoms which can bear a substituent;

Z is a moiety of formula (II):



(II)

wherein

R^3 and R^4, which may be the same as or different from each other, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing a heteroatom;

A and B are selected from sulfur (S), oxygen (O) or CR^5, wherein R^5 is selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing a heteroatom with the proviso that if A is S or O, then B is CR^5 or if B is S or O, then A is CR^5, and wherein the rings containing A and B have a double bond in the allowed position;

G is a moiety of formula (III):

(III)

wherein

R^6, R^7, R^8 and R^9, which may be the same as or different from each other, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing containing heteroatoms

belonging to groups 13-17 of the Periodic Table of the Elements, and R^6 and R^7 and/or R^8 and R^9 can form a ring comprising from 3 to 8 atoms, which can bear substituents, with the proviso that R^7 is different from R^8 and when R^7 is a tert-butyl radical, R^8 is not hydrogen;

M is an atom of a transition metal selected from those belonging to group 3, 4, 5, 6 or to the lanthanide or actinide groups in the Periodic Table of the Elements (new IUPAC version),

X, which may be the same or different, is selected from hydrogen atom, halogen atom, a group R^{10}, OR^{10}, OSO_2CF_3, $OCOR^{10}$, SR^{10}, NR^{10}_2 or PR^{10}_2, wherein the substituents R^{10} are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms;

p is an integer of from 1 to 3, being equal to the oxidation state of the metal M minus 2;

isopropylidene (3-trimethylsilylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, dimethylsilanediyl (3-trimethylsilylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, isopropylidene (3-ethylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, dimethylsilanediyl (3-ethylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, isopropylidene (3-n-butylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, dimethylsilanediyl (3-n-butylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, isopropylidene (3-methylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, dimethylsilanediyl (3-methylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride, isopropylidene (3-i-propylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride and dimethylsilanediyl (3-i-propylcyclopentadienyl)(7-cyclopentaditiophene)zirconium dichloride being excluded.

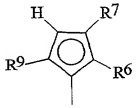
2. The metallocene according to claim 1, wherein the transition metal M is selected from titanium, zirconium and hafnium.

3. The metallocene according to any of claims 1 to 2, wherein L is CMe_2 or $SiMe_2$.

4. The metallocene according to any of claims 1 to 3, wherein A or B is a sulfur atom and the other is a CH group.

5. The metallocene according to any of claims 1 to 4, wherein R^3 and R^4 are the same and are selected from a C_1-C_{20}-alkyl group, which can contain a silicon atom.

6. The metallocene according to any of claims 1 to 5, wherein G is a moiety of formula (IIIa):



(IIIa)

wherein

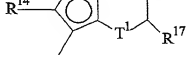
R^6 and R^9 equal to or different from each other, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements

R^7 is selected from a C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or a $QR^{11}R^{12}R^{13}$ group, wherein Q is selected from C, Si, Ge;

R^{11}, R^{12} and R^{13}, which may be the same as or different from each other, are hydrogen, C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radicals, optionally containing a heteroatom, with the proviso that when Q is a carbon atom, at least one of R^{11}, R^{12} and R^{13} is a hydrogen atom.

7. The metallocene according to claim 6, wherein R^7 is selected from phenyl, a $CHR^{11}R^{12}$ and a $SiR^{11}R^{12}R^{13}$ group, wherein R^{11}, R^{12} and R^{13} are hydrogen or C_1-C_{20}-alkyl groups.

8. The metallocene according to any of claims 1 to 5, wherein G is a moiety of formula (IV):



(IV)

wherein

T^1 is a sulfur atom or a CR^{16} group;

T^2 is a carbon atom or a nitrogen atom;

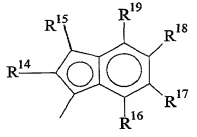
z is 1 or 0;

the ring containing T^1 and T^2 has double bonds in the allowed position;

with the proviso that if z is 1, T^1 is a CR^{16} group and T^2 is a carbon atom and the ring formed is a benzene ring; and if z is 0, T^2 bonds directly the cyclopentadienyl ring, the 5 membered ring formed has double bond in any of the allowed position having an aromatic character and T^1 and T^2 are not at the same time, a sulfur atom and a nitrogen atom.

R^{14}, R^{15}, R^{16}, R^{17}, R^{18} and R^{19}, same or different, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, any of two adjacent R^{14}, R^{15}, R^{16}, R^{17}, R^{18} and R^{19} can form a ring comprising 4 to 8 atoms which can bear substituents.

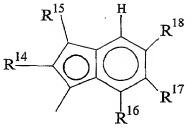
9. The metallocene according to claim 8, wherein G is a moiety of formula (IVb):



(IVa)

wherein R^{14}, R^{15}, R^{16}, R^{17}, R^{18} and R^{19}, which may be the same as or different from each other, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms, and any of two adjacent R^{14}, R^{15}, R^{16}, R^{17}, R^{18} and R^{19} can form a ring comprising 4 to 8 atoms which can bear substituents and the benzene ring can be perhydrated.

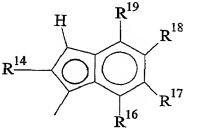
10. The metallocene according to claim 9, wherein G is a moiety of formula (IVb)



(IVb)

wherein R^{15}, R^{16}, R^{17}, and R^{18} are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, and any of two adjacent R^{14}, R^{15}, R^{16}, R^{17}, R^{18} can form a ring comprising 4 to 8 atoms which can bear substituents; R^{14} is selected from the group consisting of C_1-C_{20}-alkyl or C_6-C_{20}-aryl group.

11. The metallocene according to claim 9, wherein G is a moiety of formula (IVc)



(IVc)

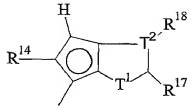
wherein R^{14}, R^{16}, R^{17}, and R^{18} are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, and optionally any of two adjacent R^{14}, R^{16}, R^{17}, R^{18} and R^{19} can form a ring comprising 4 to 8 atoms which can bear substituents;;

R^{19} is selected from the group consisting of C_1-C_{20}-alkyl or C_6-C_{20}-aryl group or forms with R^{18} a benzene ring that can bears substituents.

12. The metallocene according to claim 11, wherein R^{14} is selected from the group consisting of C_1-C_{20}-alkyl or C_6-C_{20}-aryl group such as a methyl, ethyl, or phenyl group.

13. The metallocene according to any of claima 11-12, wherein R^{16} is selected from the group consisting of C_1-C_{20}-alkyl or C_6-C_{20}-aryl.

14. The metallocene according to claim 8, wherein G is a moiety of formula (IVd):



(IVd)

wherein

T^1 is a sulfur atom or a CR^{16} group;

T^2 is a carbon atom or a nitrogen atom;

the 5 member ring formed by T^1 and T^2 has double bonds in any of the allowed position, having an aromatic character;

with the proviso that if T^1 is a sulphur atom T^2 is not a nitrogen atom;

R^{14}, R^{17} and R^{18} which may be the same as or different from each other, are selected from hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements and $R^{17}$and R^{18} can form a ring comprising 4 to 8 atoms which can bear substituents.

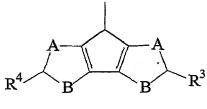
15. The metallocene according to claim 14 wherein T^2 is a carbon atom; T^1 is a sulphur atom and R^{14}, R^{17} and R^{18} equal to or different from each other are C_1-C_{20}-alkyl, C_6-C_{20}-aryl.

16. A ligand of formula (V):

LG'Z' (V)

wherein L is defined as in claims 1-5:

Z' is a moiety of formula (VI):

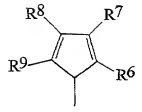


(VI)

and its double bound isomers;

wherein A, B, R^3 and R^4 are defined as in claims 1-5 and the double bonds are in any of the allowed positions;

G' is a moiety of formula (VII):



(VII)

and its double bond isomers;

wherein R^6, R^7, R^8 and R^9 have the meaning as defined in any of claims 1 to 5.

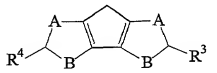
17. A process for the preparation of a ligand of formula (V):

LG'Z' (V)

wherein G', Z' and L are defined as in claim 16;

comprising the following steps:

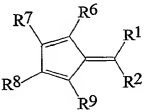
a) contacting a compound of the formula (VIII) with a base selected from the group consisting of metallic sodium and potassium, sodium and potassium hydroxide and an organic lithium compound, wherein the molar ratio between the compound of the formula (VIII) and said base is at least 1:1;



(VIII)

wherein A, B, R^3 and R^4 are described in claims 1-5;

b) contacting the corresponding anionic moiety of the formula (VIII) with a compound of formula (IX):



(IX)

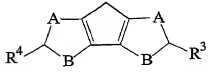
wherein R^1, R^2, R^6, R^7, R^8 and R^8 are described in claim 1 and then treating the obtained product with a protonating agent.

18. A process for the preparation of a ligand of formula (V):

LG'Z' (V)

wherein L, G' and Z' are defined as in claim 16 are defined in claim 1 comprising the following steps:

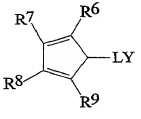
a) contacting a compound of the formula (VIII) with a base selected from the group consisting of metallic sodium and potassium, sodium and potassium hydroxide and an organic lithium compound, wherein the molar ratio between the compound of the formula (VIII) and said base is at least 1:1



(VIII)

wherein A, B, R^3 and R^4 are described as in claims 1-5;

b) contacting the obtained anionic compounds of the formula (VIII) with a compound of formula (IX):



(IX)

wherein L, R^6, R^7, R^8 and R^9 are defined as in claims 1-5 and Y is a halogen radical selected from the group consisting of chloride, bromide and iodide.

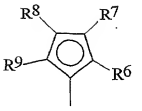
19. A process for the preparation of a metallocene compound as defined in any of claims 1 to 15, obtainable by contacting the ligand of general formula (V) with a base capable of forming the corresponding dianionic compound and thereafter with a compound of general formula MX_{p+2}, wherein M, X and p are defined as in claims 1-5.

20. A catalyst obtainable by contacting:

(A) a metallocene compound of formula (I)

$$LGZMX_p \qquad (I)$$

wherein L, Z, M, X, and p has been defined as in claims 1-5 and G is a moiety of formula (III):



(III)

wherein R^6, R^7, R^8 and R^9, which may be the same as or different from each other, are selected from the group consisting of hydrogen, a C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_2-C_{20}-alkenyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, R^6 and R^7 and/or R^8 and R^9 can form a ring comprising from 3 to 8 atoms, which can bear substituents; with the proviso that R^7 is different from R^8 and when R^7 is a tertbutyl radical R^8 is not hydrogen; and

(B) an alumoxane and/or a compound capable of forming an alkyl metallocene.

21. The catalyst according to claim 20 wherein in the metallocene compound of formula (I) G is a moiety of formula (IIIa) or (IV) wherein said moieties are defined in claims 6 and 8,

22. The catalyst according to claim 21 wherein in the metallocene compound of formula (I) G is a moiety selected from the compound of formula (IVa) (IVb), (IVc) or (IVd) wherein said moieties are defined in claims 9-15.

23. The catalyst according to any of claims 20-22, wherein said alumoxane is methylalumoxane (MAO), isobutylalumoxane (TIBAO) and 2,4,4-trimethyl-pentylalumoxane (TIOAO).

24. The catalyst according to any of claims 20-22, wherein the compound capable of forming a metallocene alkyl cation is a compound of formula D^+E^-, wherein D^+ is a Brønsted acid, able to donate a proton and to react irreversibly with a substituent X of the metallocene of formula (I) and E^- is a compatible anion, which is able to stabilize the active catalytic species originating from the reaction of the two compounds, and which is sufficiently labile to be able to be removed by an olefinic monomer.

25. A process for the preparation of a polymer of alpha-olefins comprising contacting one or more alpha-olefins under polymerization conditions with a catalyst defined in any of claims 20-24.

26. The process according to claim 25 for the preparation of homo- and copolymers of

propylene.

27. The process according to claim 26 wherein the process is carried out in the presence of an alpha-olefin selected from 1-butene, 1-pentene, 1-hexene, 4-methyl-1-pentene, 1-octene, 1-decene and 1-dodecene.

28. The process according to claim 25 for the preparation of homo- and copolymers of ethylene.

29. The process according to claim 28, wherein the process is carried out in the presence of an olefin selected from propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene, 4,6-dimethyl-1-heptene, 1-decene, 1-dodecene, 1-tetradecene, 1-hexadecene, 1-octadecene, 1-eicosene, allylcyclohexane, cyclopentene, cyclohexene and norbornene, 1,5-hexadiene, 1-6-heptadiene, 2-methyl-1,5-hexadiene, trans 1,4-hexadiene, cis 1,4-hexadiene, 6-methyl-1,5-heptadiene, 3,7-dimethyl-1,6-octadiene, 11-methyl-1,10-dodecadiene, 5-ethylidene-2-norbornene .

30. The process according to any of claims 25-29 wherein the catalyst is supported on an inert carrier.

31. The process according to any of claims 25-30 characterized in that it is carried out in gas phase.

32. A propylene homopolymer having the following characteristics:
- triads (mm) satisfy the relation $55 < mm < 85$;
- melting enthalpy (ΔH) of between 5 J/g and 70 J/g.
- Haze (ASTM 2457) from 15% to 30%;
- Gloss (60°C) (ASTM 2457) from 60% to 95%;
- Tensile modulus (ASTM D4065) from 1000 Mpa to 200 Mpa;
- Elongation at break (ASTM D4065) from 300% to 900%;
- Strength at break (ASTM D638) from 10% to 40%.

33. A propylene copolymer containing from 0.1 to 30% by moles of units deriving from an olefin of formula CH_2=CHR', R' being hydrogen, a C_2-C_{20}-alkyl or a C_6-C_{12}-aryl group, said propylene copolymer having the following characteristics:
- melting enthalpy < 70 J/g;
- triads (mm) satisfy the relation: $30 < mm < 85$.

34. The propylene copolymer according to claim 33 wherein the olefin of formula

CH_2=CHR' is ethylene.